

Appl. No. : 10/769605
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REMARKS

Claims 1, 4-7, 9-13, 15, 16, and 20-37 were pending and Claims 2, 3, 8, 14, and 17-19 were canceled prior to entry of these amendments. Claims 1, 9, 13, and 15 are amended herein. Claims 12, 24, 28, 30, 31, and 35 are canceled herein.

Rejections Under 35 U.S.C. §103

Claims 1, 4-5, 7, 9-10, 15-16, 20-23, 25-26, 29, 32, and 36-37 are rejected under 35 U.S.C. §103(a) as being unpatentable over Dubin et al., U.S. Patent No. 6,432,821 (Dubin et al. '821), as evidenced by Uzoh et al.. (US 2002/0061715). Claims 6, 11-13, 24, 27, 28, 30-31, and 33-35 are rejected under 35 U.S.C. §103(a) as being unpatentable over Dubin et al. '821 evidenced by Uzoh et al. as applied to Claims 1, 9, and 15, and further in view of Dubin et al., U.S. Patent No. 5,972,192 (Dubin et al. '192).

Independent Claims 1, 9, and 15 have been amended to recite treating a first layer or surface by applying a first anodic current waveform having a first number of pulses after applying the first cathodic current, treating a second layer or surface by applying a second anodic current waveform having a second number of pulses after applying the second cathodic current, wherein the second anodic current waveform has a longer duration than the first anodic current waveform and wherein the second number is greater than the first number. These amendments are fully supported by the specification, as originally filed, at, for example, paragraphs [0022]-[0024] and Figure 4. Claims 12, 24, 28, 30, 31, and 35 are canceled.

As noted by the Examiner, Dubin et al. '821 teach applying a first anodic current 710 and a second anodic current 718. The Examiner contends that it would have been obvious to modify the method of Dubin et al. '821 in view of Uzoh et al. by applying a plurality of anodic pulses as taught by Dubin et al. '192. The Examiner cites Uzoh et al. only for teaching that smaller cavities become filled before larger cavities. See First Office Action. Dubin'192 merely teach applying a plurality of pulses in "forward-reverse plating", but do not teach or suggest increasing the number of anodic pulses or increasing the duration of an anodic current waveform in subsequently applied anodic current waveforms. Dubin et al. '821 show various cathodic currents 702, 704, 706, 714, 722 having different durations and densities, but Dubin et al. '821 show only identical anodic currents 710, 718 (one pulse each, same durations) and do not suggest

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modifying the anodic pulses or increasing the duration of the anodic current waveform. Dubin et al. '821 note generally that the "current densities and length of times for each step of the electroplating operation are chosen so that the process as a whole provides a reduction or elimination of voids when filling small openings in an interlayer dielectric film." Dubin et al. '821, at Col. 6, lines 42-46. However, as Dubin et al. '821 show different cathodic currents, and only identical anodic currents, Applicants respectfully submit that this general teaching in Dubin et al. '821 suggests only that the cathodic currents be modified. Furthermore, Dubin et al. '821 do not teach or suggest increasing the number of cathodic pulses, much less the number and/or duration of anodic pulses. This general teaching in Dubin et al. '821 is not specific enough to suggest increasing the number and/or duration of anodic pulses or increasing the duration of a waveform in subsequently applied waveforms. Thus, Applicants respectfully submit that none of the cited references teaches or suggests increasing the number and/or duration of anodic pulses in subsequent applications of anodic current waveforms in order to inhibit bump formation over small trenches as subsequent layers are deposited to fill larger trenches.

As noted in paragraph [0022] of the present application, the use of pulsed waveforms advantageously reduces accelerator concentrations over the deposited layer and inhibits bump formation as the deposition process continues. It will be appreciated that bump formation may be inhibited by increasing the number of pulses in subsequent anodic current waveforms that are applied due to the different sizes of the trenches. As shown in Figures 3 and 4 and explained in paragraphs [0023]-[0024] of the present application, a first leveled deposition layer 119 is formed after application of a first pulsed waveform 204 (three pulses, as illustrated). This first leveled deposition layer 119 is bump free and flat over the small trenches, but the medium and larger trenches are not fully filled by the first deposition layer. As the deposition process continues, a second set of anodic pulses 208 (four pulses, as illustrated) is applied to treat a second deposited layer, which fills the medium trenches. As these medium trenches are larger than the small trenches, it will be appreciated that a greater number of anodic pulses and/or an anodic waveform of a longer duration should be applied to inhibit bump formation over the small features in the second deposited layer (filling the medium trenches) as compared to the number/duration of pulses used to treat the first deposited layer (filling the small trenches).

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None of Dubin et al. '821, Uzoh et al., or Dubin et al. '192 discloses or suggests treating a surface of the first surface or layer by applying a first anodic current waveform having a first number of pulses after applying the first cathodic current, treating a second surface of or layer by applying a second anodic current waveform having a second number of pulses after applying the second cathodic current, wherein the second anodic current waveform has a longer duration than the first anodic current waveform and wherein the second number is greater than the first number, as recited in amended Claims 1, 9 and 15. Claims 1, 9, and 15, as amended are therefore patentable as they are not obvious in view of Dubin'821, Uzoh et al., or Dubin et al. '192, either alone or in combination. Claims 4-7, 10, 11, 13, 16, 20-23, 25-27, 29, 32-34, and 36-37, which depend from and include all of the limitations of Claim 1, 9, or 15, as amended, are also patentable over the cited references. Furthermore, each of the dependent claims recites further distinguishing features of particular utility.

Conclusion

Applicants respectfully submit that all of the pending claims are patentably distinguishable over the prior art of record. The cited references, either alone or in combination, do not teach or suggest Applicants' claimed invention.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.


Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

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By: _____


Tina Chen
Registration No. 44,606
Attorney of Record
Customer No. 20,995
(415) 954-4114